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Dwarf Mistletoe Surveys on the Targhee National Forest-- 1978 Survey Results Compared to 1996 Conditions.

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Abstract

Results from roadside dwarf mistletoe surveys conducted in 1978 and 1996 on the Targhee National Forest were compared. Incidence and intensity of the parasitic plant disease in both lodgepole pine and Douglas-fir decreased. Incidence of lodgepole pine dwarf mistletoe along roadsides dropped from 89% in 1978 to 56% in 1996. Likewise, Douglas-fir roadside dwarf mistletoe incidence was 55% in 1978 and 16% in 1996. The intensity of dwarf mistletoe infections was slightly lower in Douglas-fir, and substantially lower in lodgepole pine in 1996. Incidence and intensity data from systematic plots located away from roadsides substantiate the roadside results. In the eighteen intervening years between the two surveys there was a significant shift in forest structure from mostly mature, dwarf mistletoe-infected stands in 1978 to younger, lightly infected stands in 1996. The transition likely occurred because of widespread bark beetle outbreaks and threats of wildfires that defined a Herculean salvage, regeneration, and seedling protection management strategy.

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Introduction

In 1978, a region-wide roadside survey for *Arceuthobium* spp. (dwarf mistletoe) incidence was conducted by the U.S.D.A. Forest Service. During June and July 1996, we re-surveyed one of the forests in this survey, the Targhee National Forest, to see if dwarf mistletoe incidence and intensity in lodgepole pine (*Pinus contorta latifolia*) and Douglas-fir (*Pseudotsuga menziesii*) changed in the intervening 18 years.

Methods

Methods used for the 1996 survey were identical to the 1978 survey methods which were based on a west-wide system of dwarf mistletoe surveys (Johnson et al. 1981). Surveys consisted of road transects and fixed- and variable-radius plots systematically installed at intervals along transects.

Roadside surveys were used to determine the percentage of different forest types and stand sizes with specific levels of dwarf mistletoe infections. This was done by determining the ratio of miles of tree species with dwarf mistletoe infections to the total number of miles of that species type traversed. Plot surveys were originally used to obtain the dwarf mistletoe incidence and cubic-foot volume loss assessment estimates. We used information from the plots to validate roadside survey estimates.

Roadside Survey

Forest roads were used as transects. Dwarf mistletoe occurrence was estimated by driving at low speed and inspecting a 0.1-mile long by 1-chain (66-feet) deep swath of roadside forest for signs of dwarf mistletoe infection. We assigned intensity classes, which estimated the proportion of the segment infected, to each 0.1 mile segment. An intensity rating of 0 was assigned to uninfected segments. An intensity rating of 1 was assigned to a segment if less than 1/3 of the trees in the segment were infected. A rating of 2 was assigned if 1/3 to 2/3 of the trees had mistletoe infection. If more than 2/3 of the trees in a segment had infection, a rating of 3 was recorded. The amount of area surveyed was calculated by multiplying the total length of the segments by the 66 foot width of the transect.

Plot Survey

In both the 1978 and 1996 surveys, variable- and fixed-radius plots were systematically installed at 3-mile increments. We installed both types of plots 2-chains (132-feet) into the forest, perpendicular from the road edge. For variable-radius plots, we used a wedge prism (BAF 10) to delineate sample trees. Height,

dbh, species, health status, and dwarf mistletoe rating (Hawksworth 1977) were collected for each sample tree. Only trees greater than 5-inches were sampled in the variable-radius plots. Trees smaller than 5-inches were sampled with fixed-radius plots. The radius of these plots was 11.8-feet, and plot center was the same as that of the variable-radius plot.

In the original 1978 survey, plots were designated as either Douglas-fir plots or lodgepole pine plots based on which species accounted for the majority of trees in a plot. We re-analyzed the plot data using plots with mixed species composition for both the Douglas-Fir and the lodgepole pine analyses. This allowed us to use sample data for a species even if the plot was dominated by the other species.

Dwarf mistletoe incidence for each species was calculated as the percent of survey plots infected ([no. of plots with mistletoe/total no. of plots] X 100). We also calculated the average intensity of infection for each species ([Σ{no. of infected trees/total no. of trees}/no. of plots] X 100).

Results

1996 Roadside Survey

Of the total lodgepole pine miles surveyed, approximately 56% were infected with dwarf mistletoe (Figure 1). Infection rates varied considerably within size classes with 82% of the miles grouped as mature lodgepole infected, 85% of the miles in pole-sized lodgepole infected, and only 15% of the seedling-sapling lodgepole pine miles infected.

Approximately 16% of the Douglas-Fir miles sampled were infected with dwarf mistletoe (Figure 2). Mature, pole, and seed/sap infection rates were approximately 15%, 26%, and 17% respectively.

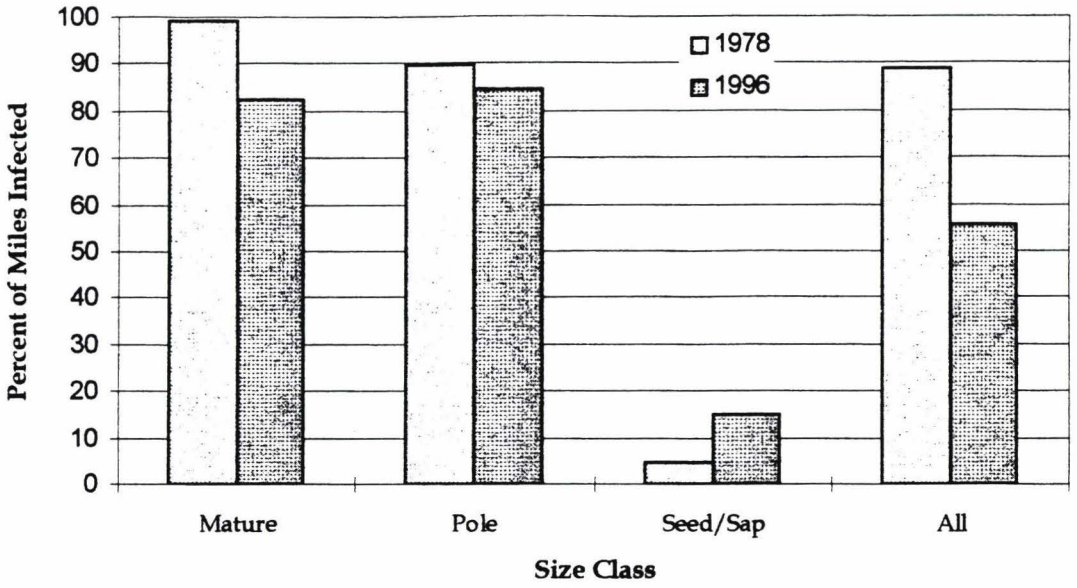

Figure 1. Incidence of dwarf mistletoe in lodgepole pine during 1978 and 1996 roadside surveys of the Targhee National Forest

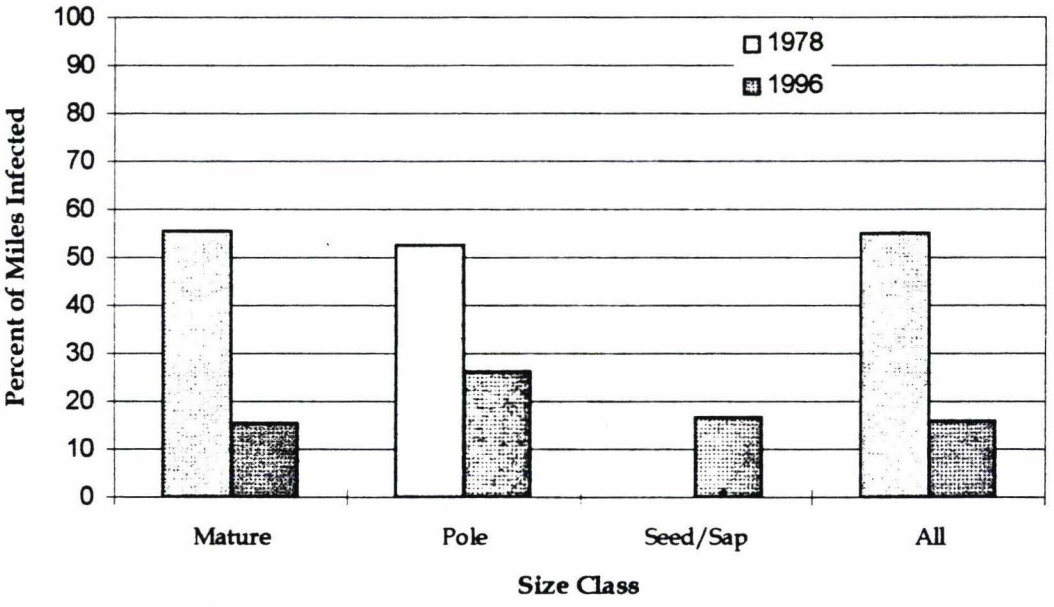

Figure 2. Incidence of dwarf mistletoe in Douglas-fir during 1978 and 1996 roadside surveys of the Targhee National Forest

Comparison to 1978 Roadside Survey

Slightly less distance was traversed during the 1996 survey. In 1978, 184.5 miles of lodgepole pine were sampled, and in 1996, 165.4 miles were sampled. Likewise, 48.2 miles of Douglas-fir were sampled in 1978, and 39.6 miles of Douglas-fir were sampled in 1996.

Large differences in dwarf mistletoe incidence (see Figures 1 and 2) and intensity (Figures 3 and 4) were apparent. For example, roadside lodgepole pine dwarf mistletoe incidence dropped from about 89% to 56%. Perhaps more importantly, the intensity of mistletoe infections in infected road segments decreased in both lodgepole pine and Douglas-fir. For example, in 1978 most of the infected lodgepole pine miles were assigned to intensity class 3 (2/3 to all of the 0.1-mile segment infected). In 1996, infected lodgepole pine miles were more evenly distributed among the intensity classes (see Figure 3).

1996 Plot Survey

Forty-three plots contained lodgepole pine, and 18 plots contained Douglas-fir (variable and fixed combined). Of the 43 lodgepole pine plots, 16 (37.2%) had dwarf mistletoe present in 1996. We recorded mistletoe infection in 3 of the 18 Douglas-fir plots (16.7%). The average Hawksworth dwarf mistletoe rating per plot was 3.2 for both species.

Comparison to 1978 Plot Survey

As with the roadside data, plot incidence rates indicate a lower lodgepole pine dwarf mistletoe infection level in 1996 than in 1978 (Figure 5). Incidence in lodgepole pine plots dropped from 73% in 1978 to about 37% in 1996, and the average percent of infected trees in plots where dwarf mistletoe was present (intensity) dropped from approximately 77% in 1978 to 61% in 1996 (Figure 6). The average dwarf mistletoe rating in infected plots was lower as well, dropping from 4.5 in 1978 to 3.2 in 1996.

Incidence in Douglas-Fir plots appeared to have changed little from 4 of 38 plots (11%) infected in 1978 to 3 of 18 plots (17%) infected in 1996 (see Figure 5). The average dwarf mistletoe rating in 1978 was 3.5 and in 1996 it was 3.2. In 1978, intensity was 100%. Intensity dropped to 56% in 1996 (see Figure 6). These differences may not represent a substantive, or even detectable change in incidence because the small sample sizes tend to inflate random error. In any case, the level of dwarf mistletoe incidence seems to be relatively low in this tree species.

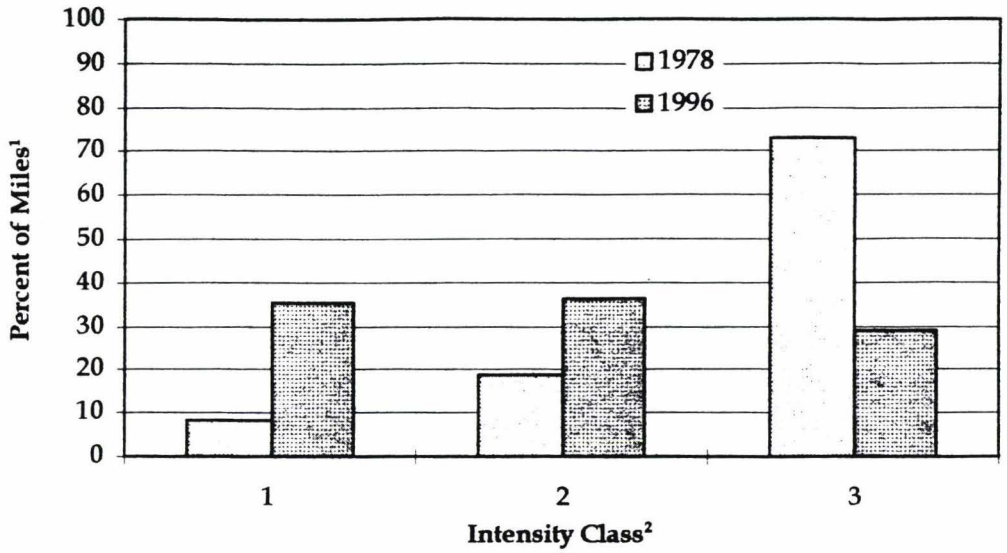

Figure 3. Dwarf mistletoe intensity in 1978 and 1996 infected lodgepole pine roadside survey miles

[1]Infected 0.1 mile segments only.

[2]Intensity classes for 0.1 mile segments: 1=0 to 1/3 of segment infected, 2=1/3 to 2/3 of segment infected, 3=2/3 to all of the segment infected.

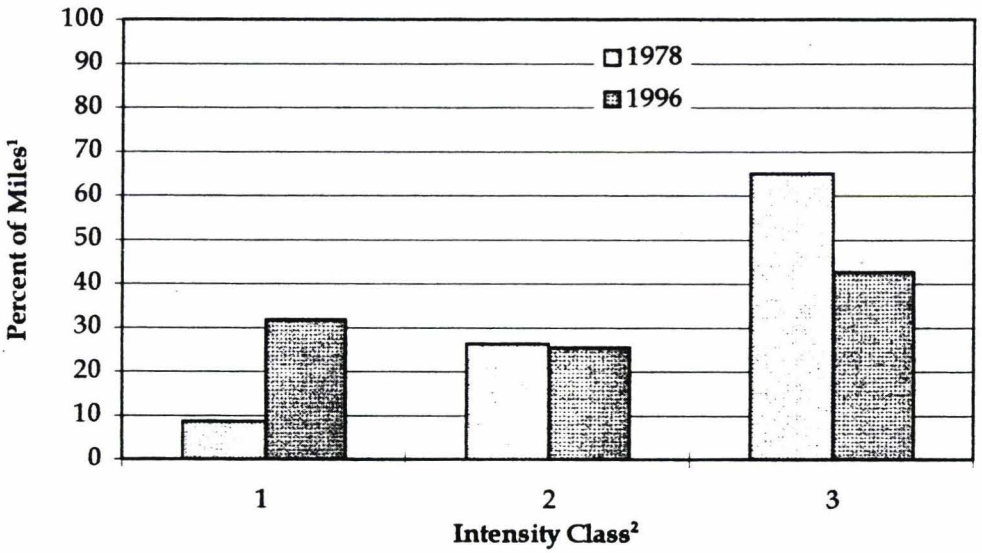

Figure 4. Dwarf mistletoe intensity in 1978 and 1996 infected Douglas-fir roadside survey miles

[1]Infected 0.1 mile segments only.

[2]Intensity classes for 0.1 mile segments: 1=0 to 1/3 of segment infected, 2=1/3 to 2/3 of segment infected, 3=2/3 to all of the segment infected.

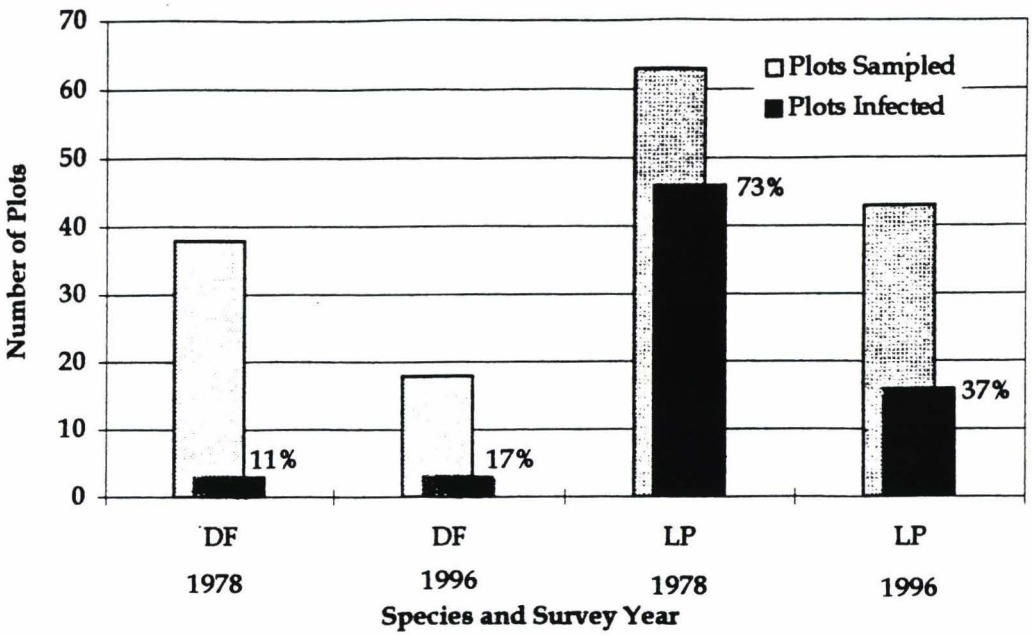

Figure 5. Incidence of dwarf mistletoe in lodgepole pine and Douglas-fir during 1978 and 1996 plot surveys

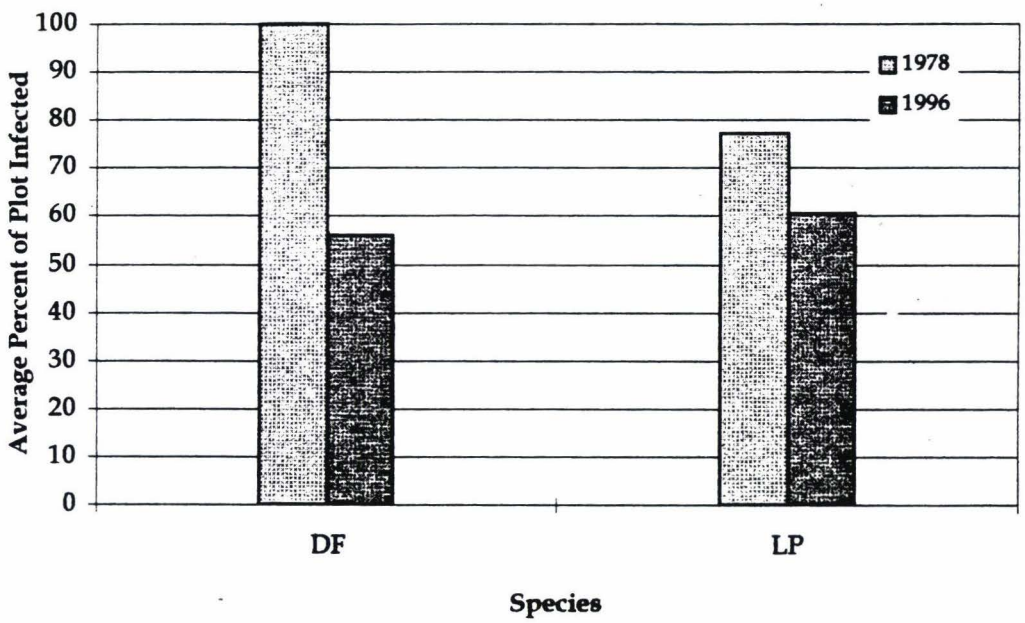

Figure 6. Average Intensity of dwarf mistletoe in infected lodgepole pine and Douglas-fir plots during 1978-1996 plot surveys

Discussion

A number of factors should be considered when interpreting the results of the 1996 roadside survey, and the comparison of these results to the 1978 survey. These factors include both methodological constraints and changes in ecological conditions relating to mistletoe infection.

First, we did not statistically analyze the results of the two surveys because of changes that had taken place between 1978 and 1996, and violations of statistical assumptions. While we did conduct the 1996 survey along the same road transects that were used in the 1978 survey, some roads had been closed, obliterated, or otherwise altered. Also, some transects were traversed in the direction opposite to the 1978 survey due to logistical constraints. Therefore, the surveys are not directly paired, and a paired-sample statistical test is inappropriate. An unpaired test is also inappropriate in this situation, because the two survey routes do not represent random, independent samples from the population (i.e. routes followed roads, which are often associated with topographic features, not randomly located). However, the effect size in terms of percentage of miles infected in 1978 and 1996 is substantial when compared to the minor differences in transect routes and total miles surveyed (11.3-miles difference). It appears highly unlikely that the sharp reduction in incidence and intensity for lodgepole pine dwarf mistletoe infection could be attributable to sampling errors or chance alone.

Second, these results should be interpreted as applying to roadside areas of the forest only. Drawing an inference about dwarf mistletoe occurrence across the whole national forest would require additional random sampling in non-roaded areas.

A third important factor in the interpretation of these results is the apparent change in forest structure that occurred between 1978 and 1996 (Figure 7). For example, mature lodgepole pine comprised 68.1% of the lodgepole pine miles surveyed in 1978 whereas only 24.4% of the 1996 lodgepole pine miles were classified as mature. Likewise, 8.4% of the 1978 lodgepole pine miles were classified as seedling/sapling, but we assigned nearly 41% of the lodgepole pine to the seedling/sapling class in the 1996 survey. This difference in forest structure is due to mountain pine beetle-caused mortality of mature trees, fires, and intensive salvage harvesting on the Targhee National Forest in the late 1970's and 1980's (Matejko and Slagle 1984). Apparent differences in size classes were not statistically tested, but very likely represent actual changes in forest structure.

The significance of the structural change to dwarf mistletoe incidence is two-fold. First, it appears that larger, and probably older, lodgepole pines were killed by mountain pine beetle or preferentially harvested between 1978 and 1996. Since younger trees are smaller targets for ejected mistletoe seeds, and they have not been exposed to dwarf mistletoe as long as older trees, they tend to have lower levels of mistletoe incidence. Second, signs of mistletoe infection are probably more easily observed in mature trees than in young trees because the mistletoe has been there longer and had more time to cause hypertrophy and brooming.

The reduction in dwarf mistletoe incidence in lodgepole pine cannot be completely attributed to the change in forest structure, however. Incidence appears to have decreased within the mature and pole size classes, regardless of the relative changes in size class frequencies between 1978 and 1996 (Figure 8). Interestingly, incidence appeared to increase between 1978 and 1996 in the seedling/sapling class in the roadside data (see Figure 1), but decrease in the plot data (see Figure 8). This could be partially caused by previous management efforts to retain green trees along roadsides as a visual screen for harvesting operations, or it could be an artifact of the small sample size for the 1978 seedling/sapling class.

As with the roadside portion of this study, caution should be taken when interpreting the results of the plot data analysis. Sample sizes are unequal between plots containing each surveyed species and the sample size is relatively small for Douglas-fir plots. However, as with the roadside data analysis, the difference in dwarf mistletoe incidence in lodgepole pine seems substantial regardless of how it is measured. It is roughly one-half the 1978 level.

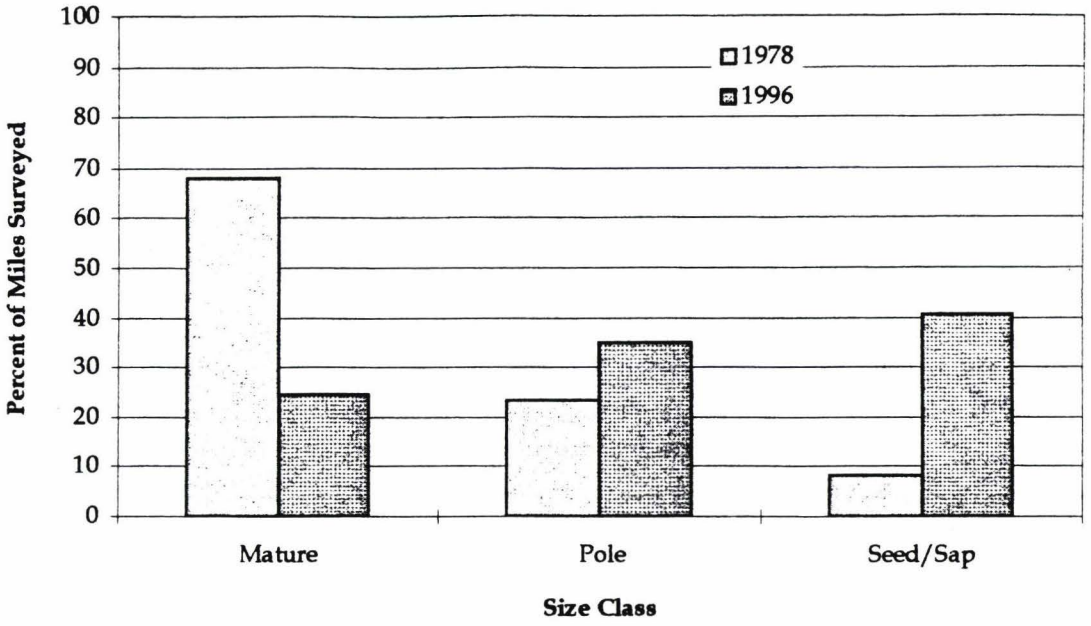

Figure 7. Percent of roadside survey lodgepole pine in three size classes in 1978 and 1996

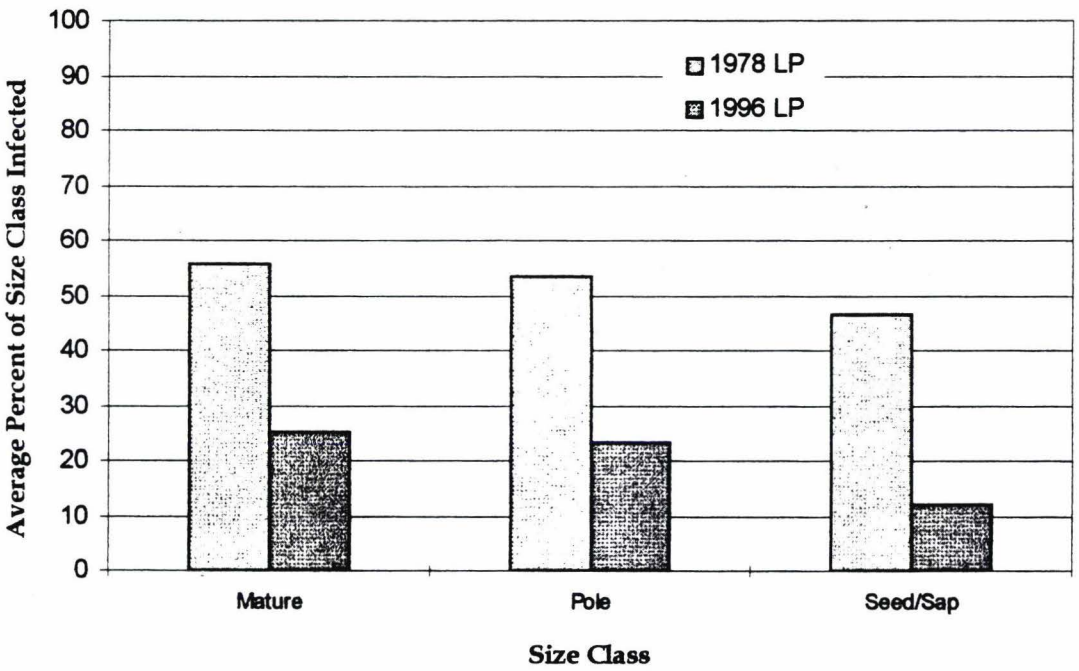

Figure 8. Average percent of three lodgepole pine size classes infected with dwarf mistletoe in 1978 (n=63) and 1996 (n=43) plots

Conclusions

The plot survey, which involved a careful inspection of individual trees, produced results very similar to the roadside survey, which was a much quicker, but presumably less accurate sampling method. Merrill and Hawksworth (1985) and Mathiasen et al. (1996) also found very strong relationships between off-road plot and roadside measurements in dwarf mistletoe surveys of Colorado and Idaho national forests. Therefore, we feel that the similarity between our plot and roadside survey results reinforce our conclusion that incidence and intensity have decreased substantially in lodgepole pine and Douglas-fir along Targhee National Forest roadsides--and probably throughout non-roaded areas of the forest as well. Statistical validation of this conclusion would require the establishment of randomly-located plots in non-roaded areas of the forest and direct pairing of roadside segments.

The Targhee National Forest has undergone dramatic changes during the years since 1978 due to infestations of mountain pine beetle, a large salvage harvesting program designed to ameliorate beetle damage, and large wildfires that occurred throughout the Greater Yellowstone Ecosystem in 1988 (Matejko and Slagle 1984). These disturbances undoubtedly affected dwarf mistletoe populations on the Targhee National Forest. However, without a detailed study of disturbance history, including management activities, we cannot determine which factors are responsible for the decline in dwarf mistletoe incidence and intensity.

Acknowledgments

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